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(54) Title: SERVER FOR MEDICAL DEVICE

(57) Abstract: One aspect of the present invention is a server for communicating with a medical device. The server comprises a web browser process for communicating with a remote device and a pump interface process for communicating with a medical device. Another aspect of the present invention is a medical device. The medical device comprises memory configured to store data and a programmable circuit in electrical communication with the memory. The programmable circuit is programmed with a web server for communicating data with a remote device. Another aspect of the invention is a server for communicating with a medical device. The server comprises memory for storing data and a programmable circuit in electrical communication with the memory. The programmable circuit programmed with an interface for communicating with a medical device.

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# SERVER FOR MEDICAL DEVICE

## Reference to Co-pending Applications(s)

The present application is a continuation of United States Provisional Patent Application serial no. 60/547,642, filed February 23, 2004, the entire disclosure of which is hereby incorporated by reference.

## Technical Field

The present invention relates to medical devices, and more particularly, a server for medical devices such as pumps.

## Background

Medical pumps are an important part of providing care to a patient. They are used for a variety of different therapies such as pain relief, nutrition, chemotherapy, and insulin. Each one of these therapies typically requires a different program for controlling operation of the pump. Additionally, each program typically requires different operating parameters for each patient depending on a variety of factors such as the substance prescribed for delivery, the prescribed dosage, and physical attributes of the patient.

Additionally, medical clinics, hospitals, or other facilities need to manage all of their medical pumps. Managing the pumps requires updating programs, loading the appropriate program into the pump depending on the prescribed therapy, loading and tracking operating parameters into the pump, and tracking performance of the pump.

All of these issues present a tremendous amount of information related to the patient and the pump that needs to be tracked, managed, and coordinated. Examples of such information includes patient records, standing orders, prescriptions, and the like. These issues also present a great deal of functionality that must be executed, managed, and coordinated. Examples include programming pumps, tracking pump inventory, downloading pump software and upgrades, monitoring and relaying alarm conditions, and tracking pump history logs.

Additionally, when an institution has a variety of different networked devices through which a caregiver would like to communicate with the pumps, each one needs to be individually programmed to communicate with the pumps. This programming drives up the cost and time required to network programmable devices and pumps. The cost and required time is even greater when the institution has a variety of different pumps and medical devices because the networked devices would require separate programming to communicate with each different make and model of medical pump or other medical device.

## Summary

In general terms, the present invention is directed to communicating with a medical device such as a pump.

One aspect of the present invention is a server for communicating with a medical device. The server comprises a web browser process for communicating with a remote device and a pump interface process for communicating with a medical device.

Another aspect of the present invention is a medical device. The medical device comprises memory configured to store data and a programmable circuit in

electrical communication with the memory. The programmable circuit is programmed with a web server for communicating data with a remote device.

Another aspect of the invention is a server for communicating with a medical device. The server comprises memory for storing data and a programmable circuit in electrical communication with the memory. The programmable circuit programmed with an interface for communicating with a medical device.

One aspect of the invention set forth herein is a pump server that provides all communication with a set of medical devices such as a medical pump. Other networked devices that exchange information (e.g., commands, instructions, or other data) with the networked medical devices communicate that information through the pump server.

Another aspect of the invention is the use of a web server to communicate with a medical device such as a medical pump. The use of a web server in this manner may permit a remote device to communicate with a medical device such as a medical pump without the use of a pump server and without the need for a special program or other interface loaded on the remote device.

## Description of the Drawings

Figure 1 illustrates a networked system that includes a medical device server and embodying the present invention.

Figure 2 illustrates an alternative embodiment of the networked system illustrated in Figure 1.

Figure 3 illustrates an alternative embodiment of the networked system illustrated in Figure 1.

Figure 4 illustrates software architecture for the pump server illustrated in Figure 1.

Figure 5 illustrates an alternative embodiment of the networked system illustrated in Figure 1.

Figure 6 illustrates an alternative embodiment of the networked system illustrated in Figure 1.

Figure 7 illustrates an alternative embodiment of the networked system illustrated in Figure 1.

Figure 8 is a flowchart illustrating a programming procedure utilizing the networked system illustrated in Figure 1.

## Detailed Description

Various embodiments of the present invention will be described in detail with reference to the drawings, wherein like reference numerals represent like parts and assemblies throughout the several views. Reference to various embodiments does not limit the scope of the invention, which is limited only by the scope of the claims attached hereto. Additionally, any examples set forth in this specification are not intended to be limiting and merely set forth some of the many possible embodiments for the claimed invention. There are alternative embodiments for all of the structures and methods disclosed herein regardless of whether specific alternatives are set forth.

Referring to Figure 1, one possible embodiment of a pump server system 10 includes a pump server 100, a point of care (POC) server 102, one or more programmable devices 104, and one or more medical pumps 106. The pump server 100 and the POC server 102 are connected to a computer network 108.

Additionally, the pump server system 10 includes communication/output devices such as a mobile phone 110, a pager 112, a fax machine 114, a printer 116, and a modem 118. The server 100 is called a "pump server" as an exemplary embodiment for purposes of explanation. The server 100 can be used to communicate with any type of medical device, including medical devices other than medical pumps.

The network 108 can be any appropriate network capable of transporting data from one device to another, including a wired network such as an Ethernet network, a wireless network such as an 802.11a/b/g or other wifi network. Additionally, the network 108 can be any type of data network such as an internal network, the Internet, or an Intranet.

The pump server 100 and the POC server 102 divide and coordinate tasks for managing information, executing various functions, and communicating with various devices within the pump server system 10. The pump server 100 and the POC server 102 can be any programmable device that stores information and performs critical functions for the storage of that information. In various embodiments, the server also might be programmed to execute various functions related to the operation and monitoring of medical pumps 106. A structure that includes a separate pump server 100 and POC server 102 has several advantages. For example, the medical pumps 106 need to be programmed and otherwise configured to interface with only one device--the pump server 100. Another advantage for institutions that utilize medical pumps 106 from different manufactures or even different pumps from the same manufacturer is that various components of networked hardware do not need to be programmed with all of the different pumps--only the pump server 100 needs to be programmed to talk directly with the medical pumps 106. As a result, it is simpler and more cost effective for a

caregiver institution to add and remove various medical pumps 106 from its inventory of equipment.

The pump server 100 communicates directly with the pumps 106 and with the POC server 102. The POC server then communicates with all of the other devices. In this exemplary embodiment, the POC server 102 instructs the pump server 100 to retrieve data from any selected medical pump 106 in communication with the network 108; instructs the pump server 100 to send data to any selected medical pump 106 in communication with the network 108; and requests data from the pump server 100 regarding any selected medical pump 106 regardless of whether the selected medical pump 106 is in communication with the network 108.

Although the exemplary embodiment illustrates an architecture in which the programmable devices 104 communicate through a POC server 102, other embodiments are possible. In various embodiments, programmable devices 104 and systems other than the POC server 102 might communicate directly with the pump server 100. Examples, include programmable devices in a biomedical engineering (biomed) department of a caregiver institution. Such biomed programmable devices might communicate with the medical pumps 106 directly through the pump server 100 for a variety of different reasons such as tracking pump performance, running pump diagnostics, or downloading pump error logs. Other systems or other departments within an institution might communicate directly with the pump server 100 as well. Other examples include a caregiver institution's pain service, which monitors and treats patient's pain, pharmacies, and computerized physician order entry (CPOE) systems, which physicians use to enter prescriptions.

The pump server stores a variety of data, executes a variety of functions, and communicates directly with the medical pumps 106 and the POC server 102 through

the network 108. In an exemplary embodiment, the pump server 100 requests and receives information (e.g., I.D. of current program and version loaded in the medical pump 106, history log, alarm status, battery state, and biomed status such as odometers, time until next scheduled maintenance, etc.) from the medical pumps 106 on the network 108; receives unsolicited messages (e.g., alarms, manual pump program changes, pre-programmed periodic updates, etc.) from the medical pumps 106; maintains a database of information retrieved from or sent to the medical pumps 106; provides a web browser interface to the medical pumps 106, which allows a caregiver to perform a variety of tasks from networked programmable devices 104 including remotely viewing the I.D. and version of the program currently loaded on a medical pumps 106, viewing the status of a medical pumps 106, and in one possible embodiment, allowing a caregiver to change various programming parameters such as setup and titration; providing pump alert functionality such as sending emails, pages, or notices to client applications upon the occurrence of certain pump events (e.g., alarms, programming changes, patient tampering, ratio of dose attempts to doses given too high indicating the patient pain is not adequately controlled, and programming that exceeds soft limits programmed into the medical pump 106); sending messages to the display on the medical pumps 106 (e.g., when alarms are acknowledged, display message to patient stating that nurse is on the way); sending voice messages to the medical pumps 106 (e.g., when alarms are acknowledged, tell patient that nurse is on the way); sending messages (e.g., medical pump 106 needs reservoir changed at approximately 8:00 pm) to the printer 116 or the fax 114 at a nursing station; providing information (e.g., electronic copy of manuals, troubleshooting guides, patient guides, etc.) about the medical pumps 106 to a caregiver using programmable devices 104; verifying the software

revision for programs loaded on the medical pumps 106 and downloading new or updated software to the medical pumps 106; and controlling pump and document results during biomed testing processes.

In another possible embodiment, the pump server 100 implements Standing Order protocols. An example of implementing Standing Order protocols is described in United States Provisional Patent Application Serial No. 60/526,810, which was filed on December 4, 2003 and entitled "PROGRAMMING MEDICAL PUMPS WITH ELECTRONIC STANDING ORDER TEMPLATE," the disclosure of which is hereby incorporated by reference. In this embodiment, the pump server 100 enables the creation, storage, and management of a database of Standing Orders; processes requests from the medical pumps 106 to send it an index of standing order protocols or specific standing orders; sends Standard Orders-based protocols to the medical pumps 106; and sends updated library of Standing Orders-based protocols to the medical pumps 106;

Additionally, the pump server 100 is programmed to provide notification to a caregiver about when it is time to check on a patient. For example, the pump server 100 might generate a notification to check on a patient or check fluid levels every two hours. Notification can be through any suitable means such as a pop-up window on a programmable device, a pager, a cell phone, a printer, a fax, or the like.

In yet another possible embodiment, when a medical pump 106 is programmed, the pump server 100 disables the medical pump 106 until its programmed parameters (e.g., delivery protocol) are reviewed by a caregiver at the point of care. In one possible programming procedure as illustrated in Figure 8, when a medical pump 106 is programmed, the pump server 100 sends a disable signal or command to the medical pump 104 at operation 140. Pumping operation

of the medical pump is then disabled. The caregiver programs the medical pump 106 while it is disabled at operation 142. After programming is complete, the caregiver reviews the programmed settings at operation 144. In one possible embodiment, the medical pump 106 automatically indexes through the programmed settings. In another possible embodiment, the caregiver must press a button or activate a menu item to acknowledge that the programmed settings were reviewed and accurate. After the programmed settings are reviewed, the medical pump 106 sends a signal to the pump server 100 at operation 146, and the pump server 100 replies to the medical pump 106 with an enable signal on command at operation 148. The medical pump can then pump fluid as programmed.

The pump server 100 can have different locations depending on the desired embodiment. In the exemplary embodiment, the pump server 100 is located at the caregiver's facilities. In another possible embodiment, the pump server 100 is located at a third party, such as the pump manufacturer or other third-party administrator.

The medical pump 106 can be any medical pump configured for infusing a fluid into a patient. It includes a data port configured for communicating with the network 108. Examples of possible data ports for the medical pump 106 includes a wireless data card for transmitting according to the 802.11 a/b/g, Bluetooth, or other appropriate wireless networking protocol, USB data ports, firewire data ports, RS-232 data ports, an infrared data port, a modem, or any other data port capable of communicating with the network 108 or directly with the pump server 100. In the operation of one possible embodiment, the medical pump 106 talks directly and only to the pump server 100 via the network 108. Accordingly, the medical pump 106

requires no knowledge or programming for interfacing with and talking to the POC server 102 or other devices in the pump server system 10.

In one possible embodiment, the programmable devices 104 communicate with the POC server 102 via the network 108 and do not communicate directly with the pump server 100 of the medical pumps 106. The programmable devices can include any type of computing platform capable of data input and interfacing with the network 108. In various embodiments, the programmable devices 104 are mounted in a convenient location such as a hospital room, nurse's station, or other location convenient for the caregiver. Additionally, another embodiment includes a desk-top computer on a cart that can be conveniently rolled from one location to another. Examples of various programmable devices 104 include a pen-based computer such as a Tablet PC, a lap-top computer, a desk-top computer, or a hand-held computing platform such as a personal digital assistant (PDA). Additionally, one possible embodiment of the PDA can include a bar code reader or radio frequency ID (RFID) reader capable of scanning a barcode or RFID tag, respectively, on a medical pump 106 and then communicating this information to the POC server 102.

Figure 2 illustrates an alternative embodiment in which the programmable devices 104 and the communication/output devices such as a mobile phone 110, a pager 112, a fax machine 114, a printer 116, and a modem 118 communicate directly with the pump server 100 without a POC server 102.

Figure 3 illustrates another possible embodiment that includes additional point of care medical devices 120 such as a pulse oximeter. As with the medical pumps 106, the other medical devices 120 communicate directly with the pump server 100 over the network 108 rather than communicating with other networked

devices. In this embodiment, the pump server 100 is programmed to selectively associate various medical devices 120 and/or medical pumps 106 using a set of programmed rules that a caregiver may define. For example, the pump server 100 can be programmed to start or stop operation of a medical pump 106 based on data received from another medical device 120 (e.g., if respiration drops below a predefined limit, the pump server 100 instructs the medical pump 106 to stop pumping and generates an alarm). The pump server 100 also selectively provides a virtual connection between the various medical pumps 106 and medical devices. As a result, the medical devices 120 and medical pumps 106 do not need to be programmed to talk directly with each other. Again, because each medical device does not need to be individually programmed, this functionality makes it easier and less costly to add various devices to the inventory of equipment. As with medical pumps 106, the pump server 100 is programmed to generate and/or communicate various alerts for the medical devices 120 via pages, e-mail, faxes, printouts, voice messages, etc.

Figure 4 illustrates one possible embodiment of the architecture for the pump server 100. In this embodiment, the pump server 100 includes an interface 122 for communicating with the POC server 102 and a Web server 124, which allows other devices such as the programmable devices 104 to remotely interface with the medical pumps 106 or other medical devices 120. The web server 124 allows the other devices to communicate with the pump server 100 using standard text files without the need of loading special software such as interfaces, communications software or other programs into the remote or other devices. A remote device includes any device that is a separate and distinct device from the medical device 120. Examples of standard text files include files formed according to a markup

language such as a hypertext markup language (HTML), standard generalized markup language (SGML), and eXtensible markup language (XML).

The pump server 100 is also programmed with various code and logic 126 for executing various tasks and functions described herein and an information manager 128 for storing and retrieving pump information in a database 130. A pump interface manager 132 provides an interface for the medical pumps 106. In various embodiments, the pump interface driver 134 for the medical pump 106 itself is programmed into the pump server 100, or in an alternative embodiment, the pump interface driver 136 is either programmed in the medical pump 106 itself or in a programmable module attached to the medical pump 106. Additionally, one possible embodiment allows the medical pump 106 to have a direct connection 138 to the pump server 100.

Figure 5 illustrates a possible embodiment in which a programmable device 104a is programmed to function as a pump server. In this embodiment, the programmable device 104a performs the same functions as the pump server 100 as described herein. Additionally, the programmable device 104a can request and receive information from medical pumps 106 that are remotely located at a location such as a patient home or a medical pump 106 that is not otherwise provided with a direct network connection. The connection between the programmable device 104a and the medical pump 106 is through a dialup connection using a modem 118. The medical pump 106 can connect to the modem 118 through a wired or wireless connection such as a connection operating according to the Bluetooth protocol. Either the programmable device 104a or the medical pump 106 can initiate a data connection between the two. Accordingly, the programmable device 104a can request and receive information about any medical pump 106 or other medical

device 120 that is not on the network 108 as otherwise described herein. Additionally, the medical pump 106 or other medical device 120 can transmit to the programmable device 104a unsolicited messages such as alarms, manual pump changes, pre-programmed period updates, etc.

Figure 6 illustrates the possible embodiment in which the programmable devices 104 communicate directly with the pump server 100 through a web server programmed in the pump server. In this embodiment, any networked programmable device 104 with a web browser can communicate with the medical pump 106 or any other medical device. An advantage of this embodiment is that a caregiver can connect to the medical pump with wireless and remote devices to check the status of the medical pump 106 or other any medical device when not physically with the patient or located at a site where there is a networked programmable device 104. Another advantage is that the programmable devices 104 do not need to be individually programmed to communicate with the pump server 100.

Figure 7 illustrates another possible embodiment in which the pump 106 or other medical device 120 is itself programmed with a web server, which allows the medical device 120 to communicate with the pump server 100 or directly with other or remote devices using standard text files without the need of loading special software such as interfaces, communications software, or other programs into the other devices. Again, examples of standard text files include files formed according to a markup language such as a hypertext markup language (HTML), standard generalized markup language (SGML), and eXtensible markup language (XML).

An advantage of this embodiment is that a caregiver can connect to the medical pump with wireless and remote devices, from any distance, to check the status of the medical pump 106 or other medical device 120 when not physically

with the patient or located at a site where there is a networked programmable device 104. Additionally, two programmable devices 104 can be simultaneously connected to the same medical pump 106 or other medical device 120 for training and troubleshooting. Additionally, a medical pump 106 or other programmable device 120 can be utilized without a display and without a keyboard. Another advantage is that because the web server provides an interface using a standardized protocol to communicate information such as serving up documents, files, scripts, and other information, no further program or control application need be written for the programmable devices 104.

The various embodiments described above are provided by way of illustration only and should not be construed to limit the invention. Those skilled in the art will readily recognize various modifications and changes that may be made to the present invention without following the example embodiments and applications illustrated and described herein, and without departing from the true spirit and scope of the present invention, which is set forth in the following claims.

**The claimed invention is:**

1. A server for communicating with a medical device, the server comprising:

a web browser process for communicating with a remote device; and

a pump interface process for communicating with a medical device.

2. A medical device comprising:

memory configured to store data; and

a programmable circuit in electrical communication with the memory, the programmable circuit programmed with a web server for communicating data with a remote device.

3. A server for communicating with a medical device, the server comprising:

memory for storing data; and

a programmable circuit in electrical communication with the memory, the programmable circuit programmed with an interface for communicating with a medical device.

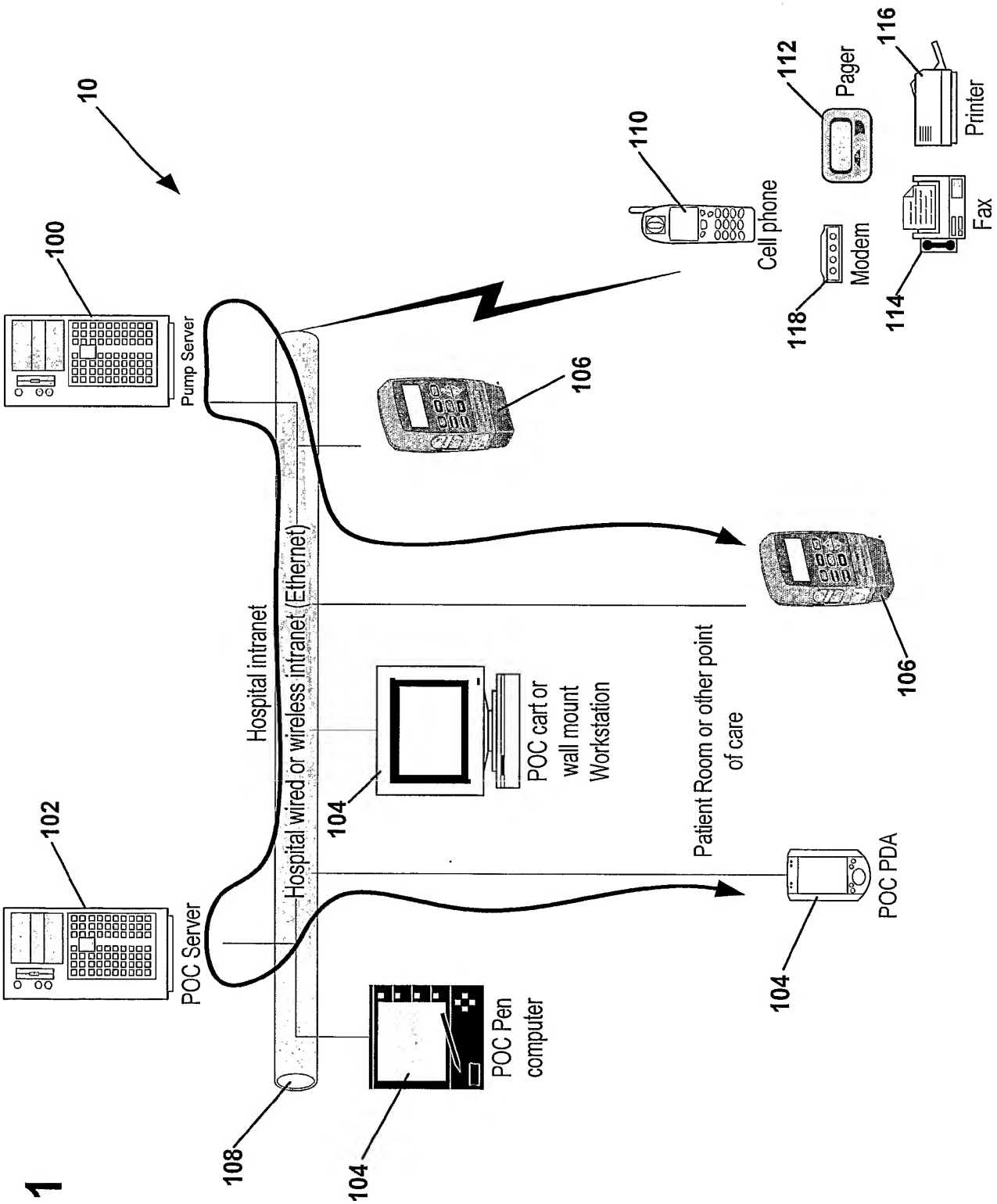

10
100
Pump Server
102
POC Server
Hospital intranet
Hospital wired or wireless intranet (Ethernet)
108
104
POC Pen computer
104
POC cart or wall mount Workstation
106
Patient Room or other point of care
104
POC PDA
106
110
Cell phone
112
Pager
116
Printer
118
Modem
114
Fax

Fig. 1

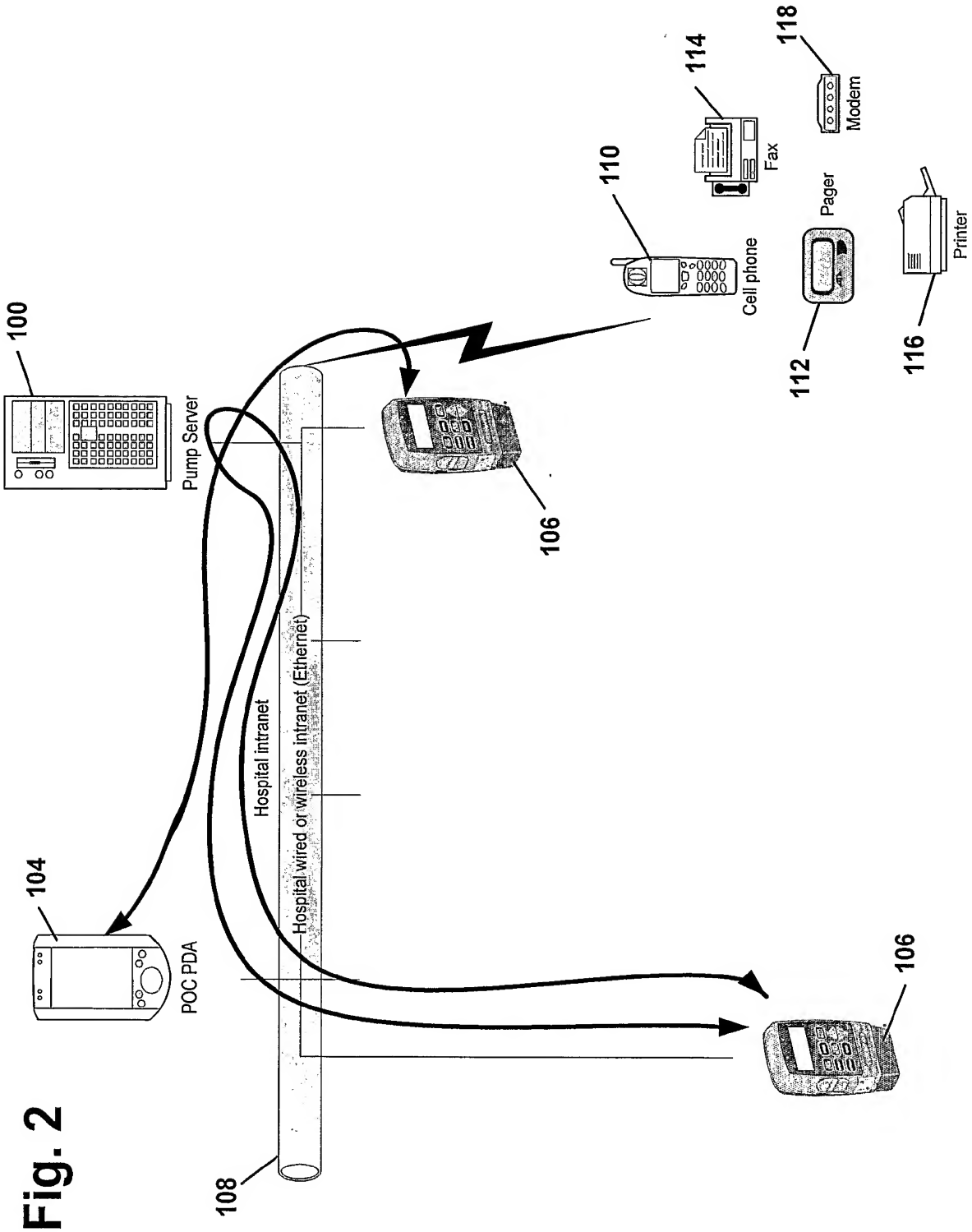
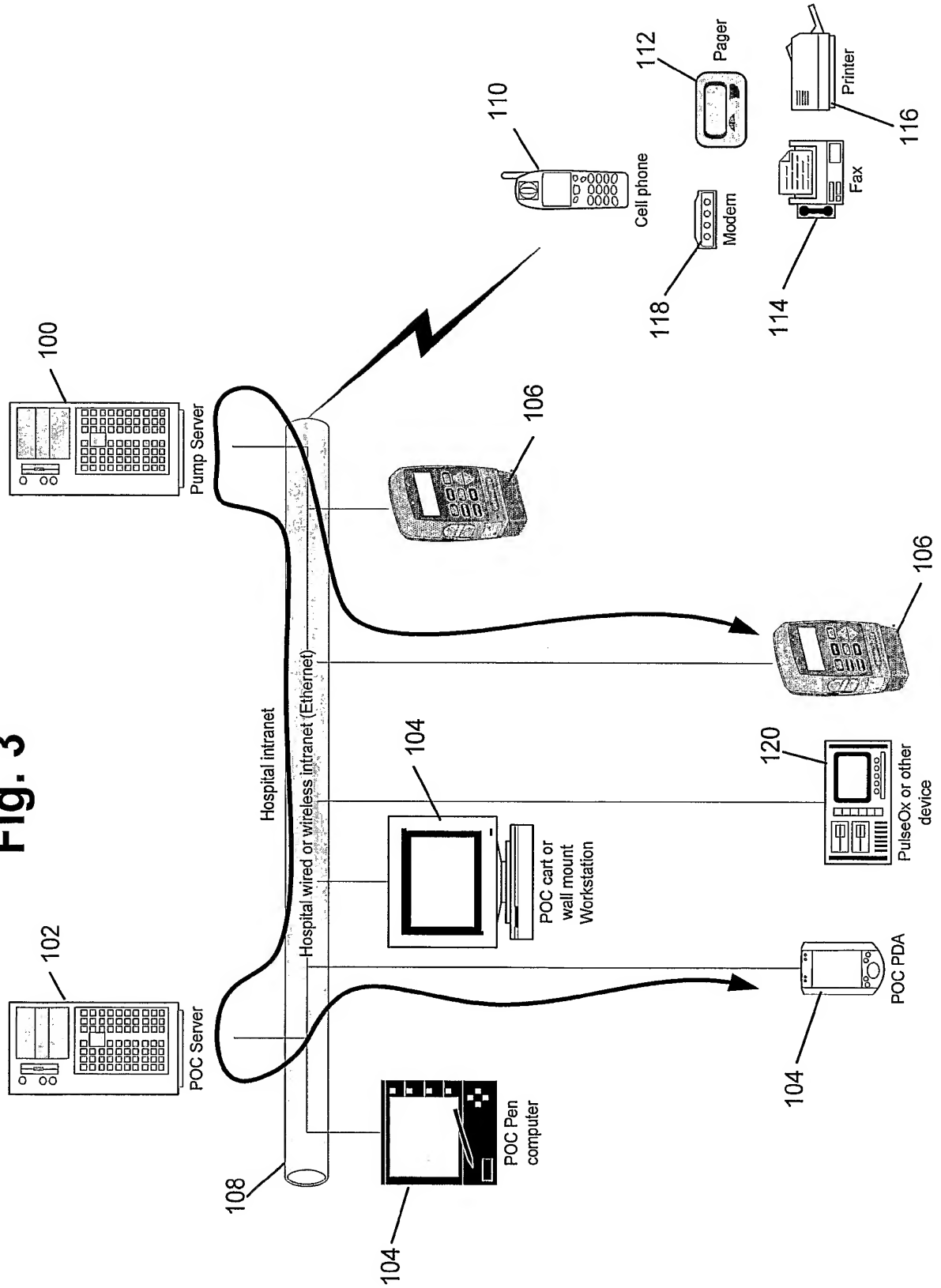

100
Pump Server
104
POC PDA
Hospital intranet
Hospital wired or wireless intranet (Ethernet)
108
106
106
110
Cell phone
114
Fax
118
Modem
112
Pager
116
Printer

Fig. 2

Fig. 3


100
Pump Server
102
POC Server
108
Hospital intranet
Hospital wired or wireless intranet (Ethernet)
104
POC Pen computer
104
POC cart or wall mount Workstation
106
106
110
Cell phone
112
Pager
Printer
116
Modem
118
Fax
114
120
PulseOx or other device
104
POC PDA

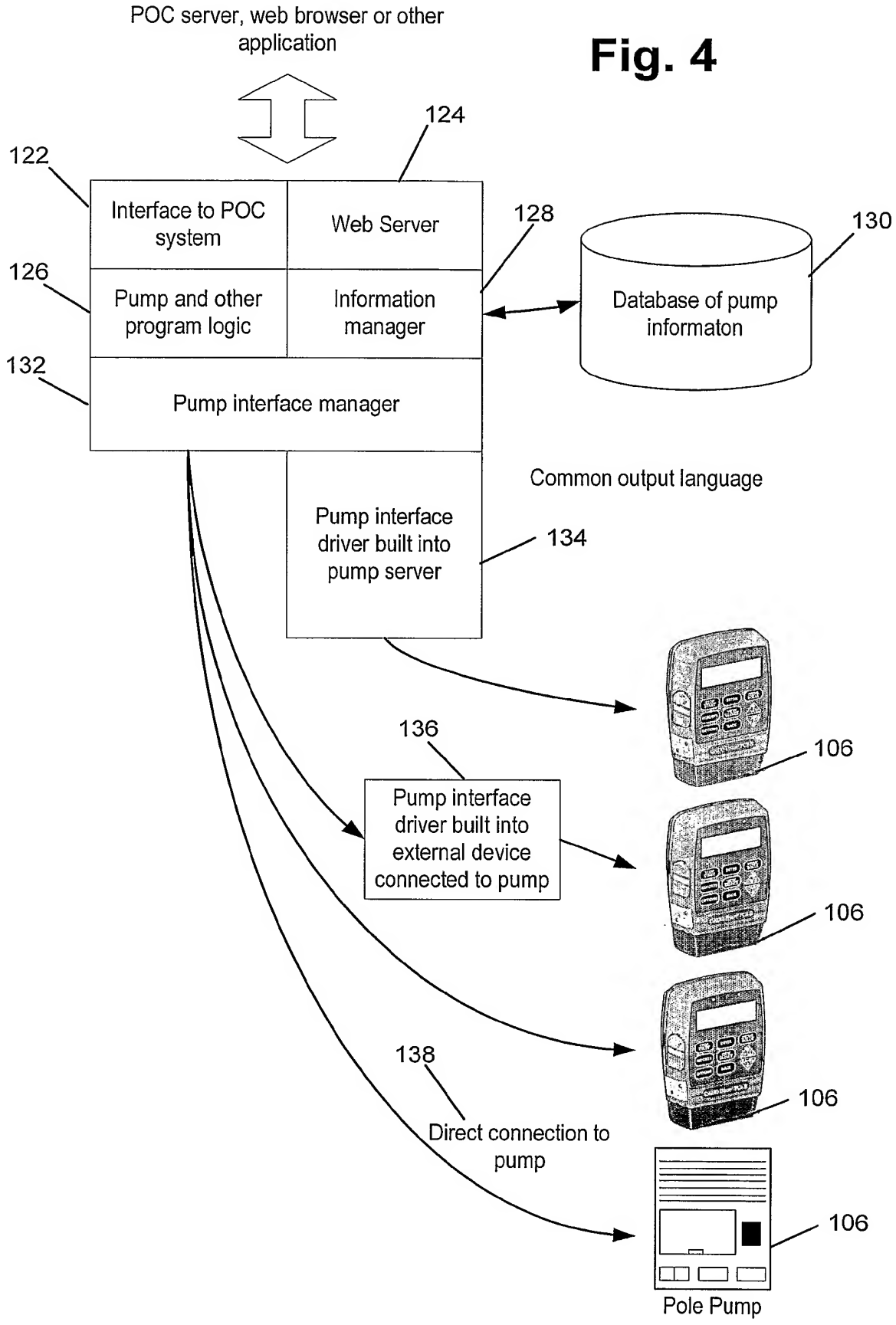

POC server, web browser or other application
124
122
Interface to POC system
Web Server
128
130
126
Pump and other program logic
Information manager
Database of pump informaton
132
Pump interface manager
Common output language
Pump interface driver built into pump server
134
136
Pump interface driver built into external device connected to pump
106
106
106
138
Direct connection to pump
106
Pole Pump

Fig. 4

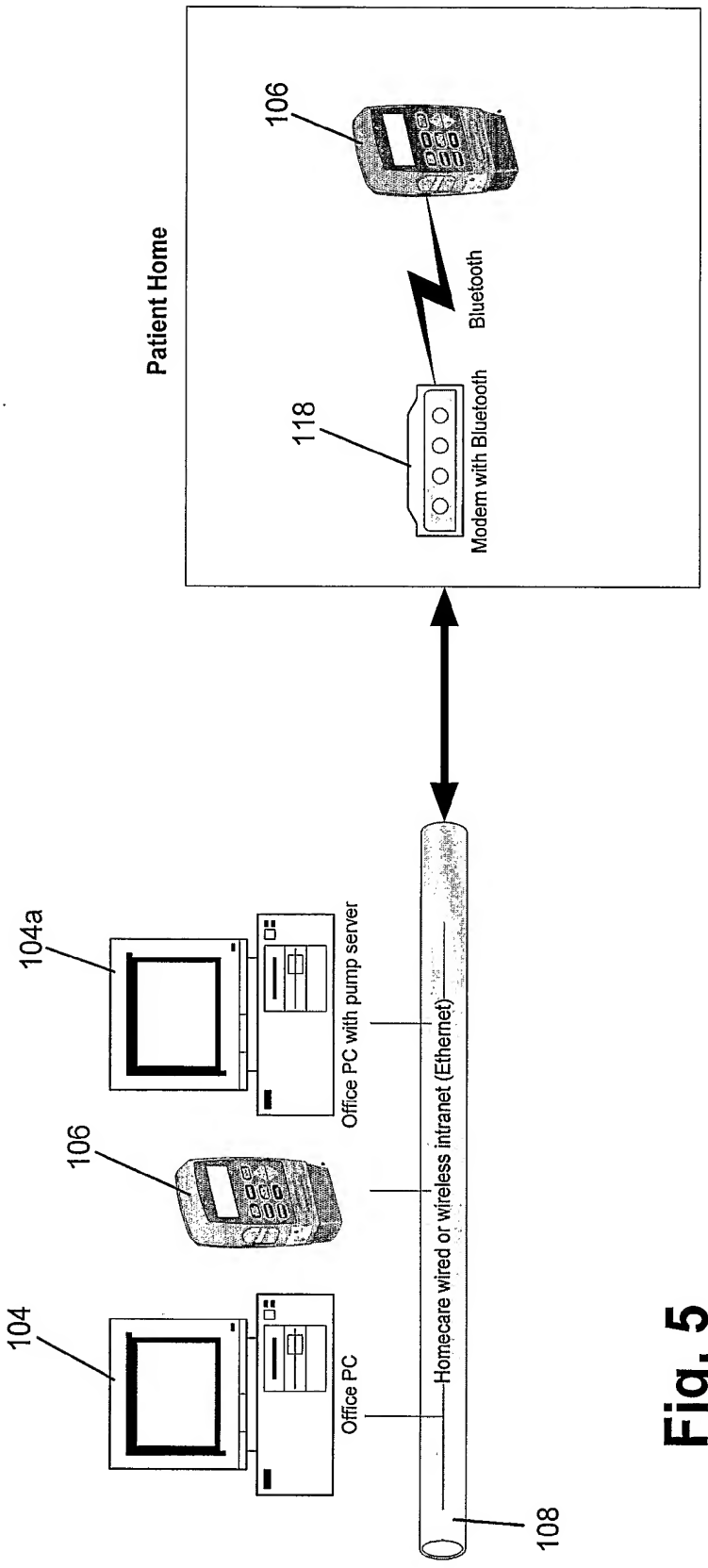

Patient Home
106
Bluetooth
118
Modem with Bluetooth
104a
Office PC with pump server
106
104
Office PC
Homecare wired or wireless intranet (Ethernet)
108

Fig. 5

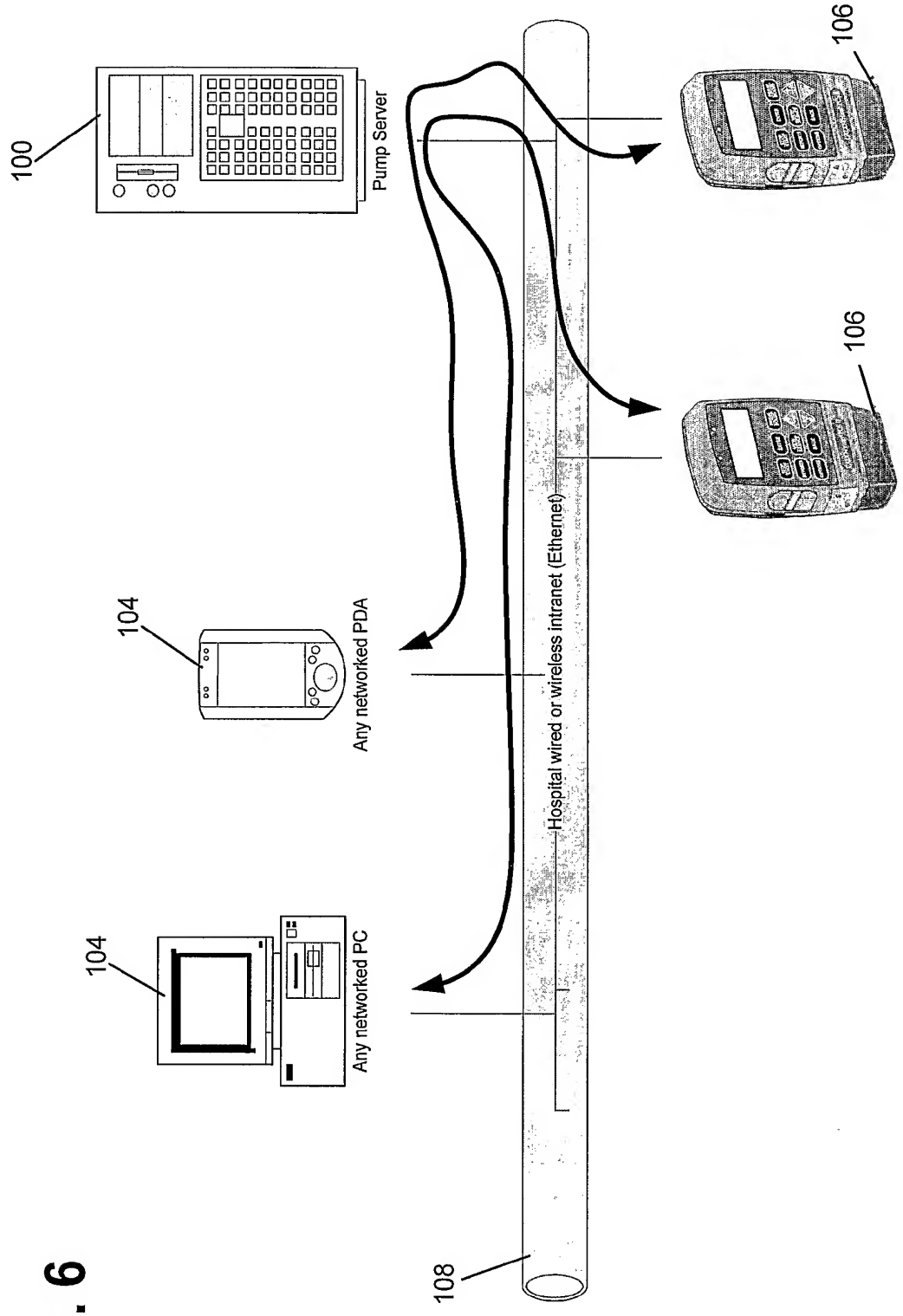

100
Pump Server
106
106
104
Any networked PDA
104
Any networked PC
Hospital wired or wireless intranet (Ethernet)
108

Fig. 6

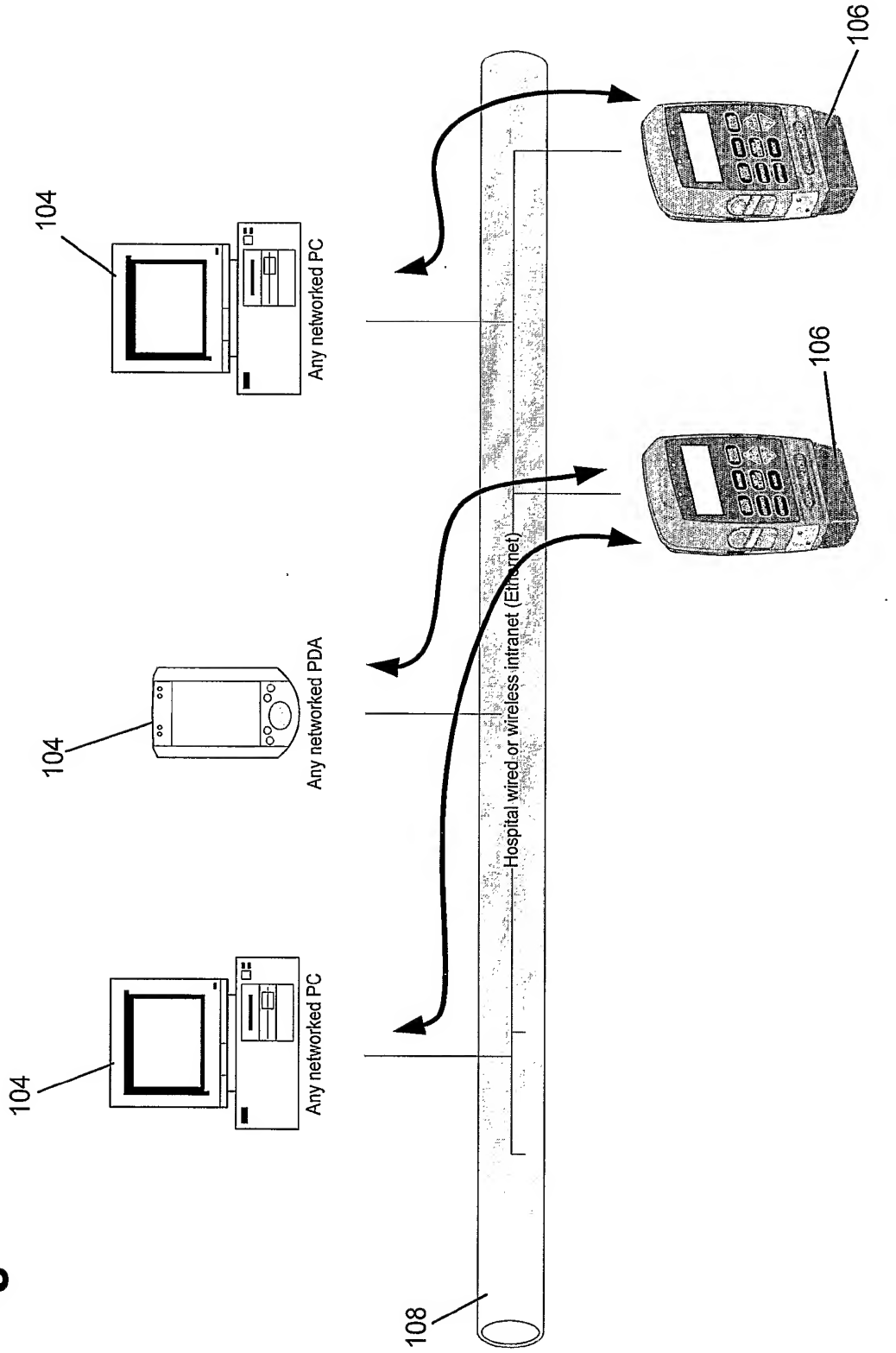
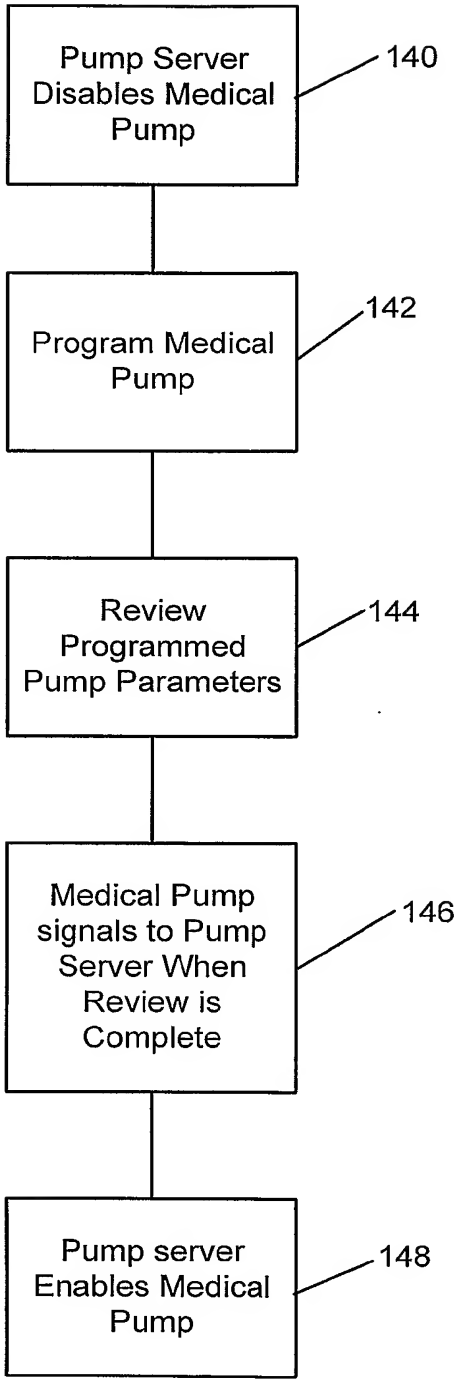

104
Any networked PC
104
Any networked PDA
104
Any networked PC
Hospital wired or wireless intranet (Ethernet)
106
106
108

Fig. 7

# Fig. 8


Pump Server Disables Medical Pump
140
Program Medical Pump
142
Review Programmed Pump Parameters
144
Medical Pump signals to Pump Server When Review is Complete
146
Pump server Enables Medical Pump
148